Executive Summary

Introduction

The Mattress Recycling Council (MRC), a non-profit organization that administers mattress recycling programs in states with mattress product stewardship laws, sponsored a life cycle analysis (LCA) of its California mattress recycling operations conducted for calendar year 2021. This Annex executive summary presents updated results of the critically reviewed Life Cycle Assessment (LCA) of mattress recycling in California. The original LCA study and this update have been conducted by Scope 3 Consulting, LLC. The study baseline covers mattress recycling activities during 2021. The original critically reviewed LCA report was delivered in 2023. This Annex incorporates updated market information that was not available during the critical review period.

For more background on the study, the complete methodology, and the critical review verification, please refer to the full LCA report and the annex.

Key Findings

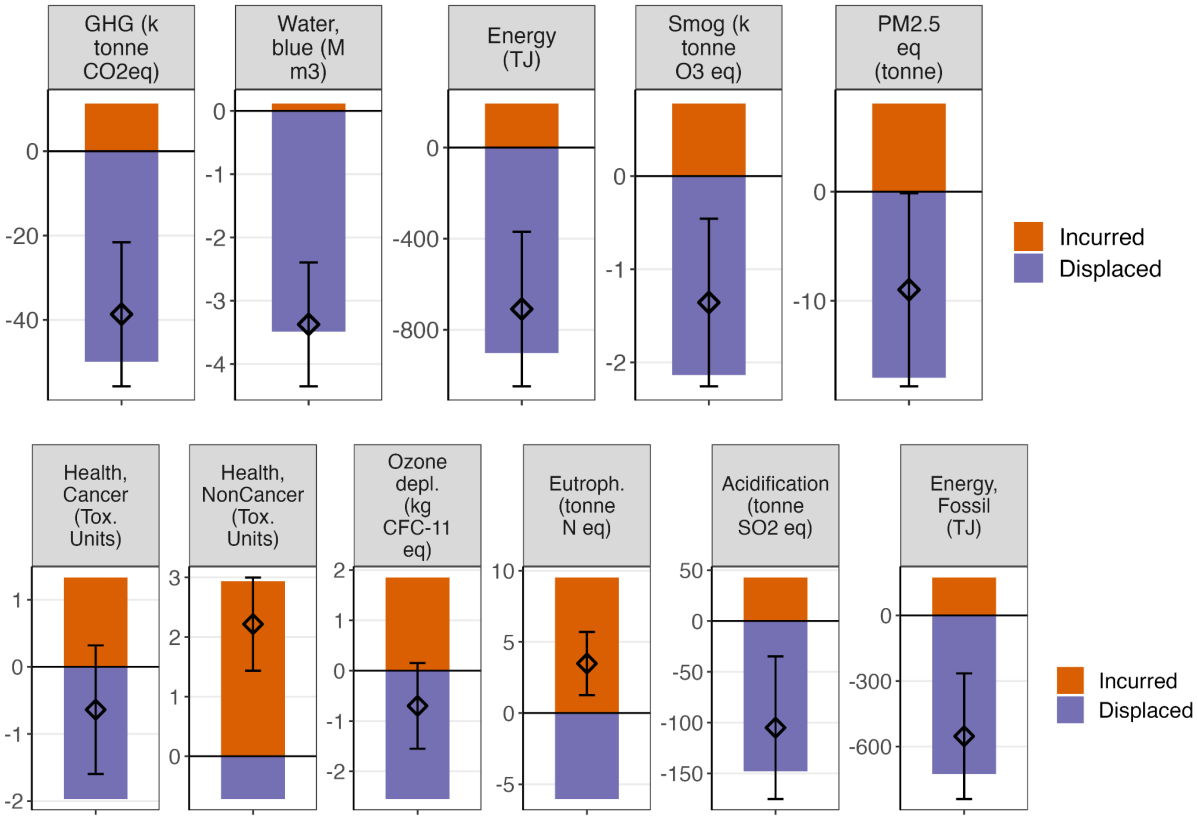
Baseline Performance

In 2021, the California program recycled 1.6 million mattresses. Of the 40.7 thousand metric tons (90 million lbs.) of materials recovered, 31.4 thousand tons (77%) were recycled, and 9.3 thousand tons (23%) were landfilled. The assessment of the 2021 recycling system found that it provides the following net environmental benefits:

- Greenhouse gas reduction: 39,000 metric tons (86 million lbs.) CO_2 equivalents
- Energy demand reduction: 710 terajoules (200 million kWh)
- Blue water demand reduction: 3.4 million m^3 (900 million gallons)
- Particulate matter reduction: 9.0 metric tons PM2.5 equivalent (20 thousand lbs.)
- Smog reduction: 1,360 metric tons O_3 equivalents (1810 thousand lbs.)

According to the LCA model, the mattress recycling system provided environmental benefits in all 5 of the headline study indicators. For supplemental indicators, the overall impact was mixed. Four of the indicators showed net benefits (ozone depletion; acidification; fossil energy; cancer health), while two had consistently worse performance (non-cancer health; eutrophication). The Full ISO-compliant report defines these indicators, explains the modeling methods, and discusses findings in greater detail. Incurred impacts, avoided impacts (displacement), and net results are illustrated in Figure ES.1

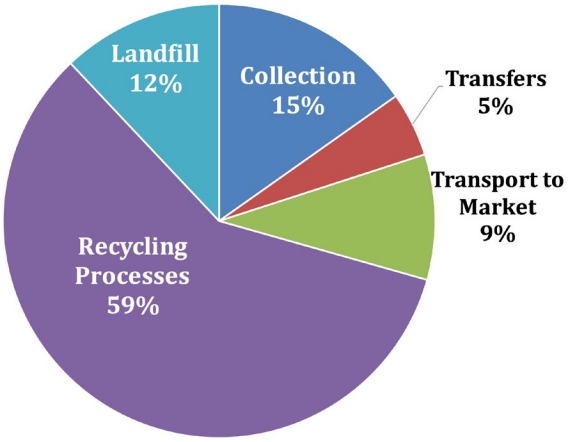
Figure ES.1. Total system impacts for managing 41 thousand tonnes (kt) of used mattresses. Each pane shows the incurred, displaced, and net total impacts of mattress recycling in CA (yr2021). The Diamonds represent the Net total. Top five panes show the headline indicators; bottom panes show the six supplemental indicators. The Error bars show net total results for a range of assumed displacement rates. Tabular data in §Data Tables. See the Full Report, §*Displacement Rates* for explanation, and §*Displaced Production* for ranges.



Incurred Impacts

The *incurred* environmental impacts are from processes related to used mattress collection, transportation, deconstruction, reclamation, transport of extracted mattress materials to final disposition, and remanufacturing. Figure ES.2 illustrates the major drivers for incurred greenhouse gas emissions resulting from the mattress recycling system. Within the Recycling Processes category, the activity of California recyclers and rebond foam pad production are major drivers. The production of methylene diphenyl diisocyanate (MDI) used in rebond foam pad production is also a significant contributor to the Recycling Processes impacts.

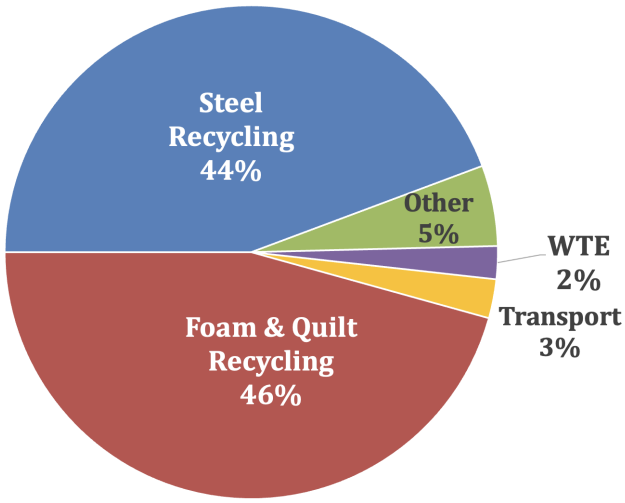
Figure ES.2. Incurred greenhouse gas impacts by process. Estimate of total incurred was 11.3 KT CO_2eq / yr.



Material, Product and Energy Displacement

In addition, the study reports potentially avoided impacts (*displaced*), which would be realized if the supply of recycled materials from mattresses displaces primary (virgin) materials. This relationship between the supply of mattress-derived materials and the displaced production of primary materials is an important uncertainty in this study. For this reason, we model a range of displacement values (depending on the material), and always show incurred impacts (from the mattress recycling system) and potentially avoided impacts (from displaced production), not just a net total. Figure ES.3 illustrates that the major drivers for avoided greenhouse gas impacts were steel recycling and avoided polyurethane foam production.

Figure ES.3. Greenhouse gas displacement drivers by material. Estimate of total displaced climate impact was 50 KT CO_2eq per year.



Net Impacts

For climate impact, water use, smog, energy use, and particulate matter, the magnitude of the potentially displaced impacts is consistently larger than the incurred impacts of the recycling system. Even with the most pessimistic assumption about displacement, the results indicate net benefits from the mattress recycling system.

Alternative Process Assessments

As mentioned previously, global industry research and investments are in progress to develop new pathways for recycling end-of-life materials. This LCA study made a preliminary assessment of several of these technologies.

Initial findings indicate that all established recycling processes, including mechanical recycling, chemical recycling, incineration, and pyrolysis, are more preferable options than landfilling. Chemical recycling has similar environmental impacts, compared with the current mechanical recycling processes and market channels. However, it is important to note that the model relies on publicly available proxy data for the chemical recycling facility. Evaluation of an actual commercial-scale chemical recycling facility is necessary to arrive at a firm conclusion.

Improvement Opportunities

The study identified potential short- and long-term opportunities for improving the environmental impacts of mattress recycling.

Transportation of mattresses from collection nodes to recyclers and recovered materials to secondary markets represented approximately 30% of incurred climate impacts. The number, size, and location of collection nodes and primary and secondary recycling facilities are important considerations as the mattress recycling industry expands.

Automation to improve recyclers' ability to efficiently separate materials has the potential to increase throughput for recyclers. However, the impact on recovery rates and landfill rates will affect the overall environmental performance.

Development of new end markets for recovered materials remains a key driver for growing and diversifying demand. To maintain and improve current baseline performance, recycling rates for all materials recovered should exceed 75% and must be robust through economic cycles.

Conclusion

The LCA found that the current industry-led product stewardship program offers environmental benefits in all 5 of the headline indicators. Even under the most pessimistic assumptions, the recycling system provides environmental benefits in all 5 of the headline indicators. According to the best estimates of the study, approximately 39,000 metric tons (86 million pounds) of greenhouse gases were avoided when compared with the production of products from virgin raw materials – the same amount as burning 3.8 million gallons of diesel. The program also saved an estimated 900 million gallons of water and mitigated the production of 710 terajoules of primary energy.

This Annex (Q1 2024) is derived from the Full LCA Report that follows ISO 14040 and 14044 guidelines. The full report was critically reviewed by an independent panel of LCA and subject experts and was found to be in conformance with the ISO standard. This Annex (Q1 2024) presents updates to the Full Report based on updated information about the fate of recycled quilts and the status of the scrap foam market.